A.D. 1870, 8*th April.* N° 1044.

Electric Telegraphs.

LETTERS PATENT to Cromwell Fleetwood Varley, of Beckenham, in the County of Kent, for the Invention of "IMPROVEMENTS IN ELECTRIC TELEGRAPHS."

Sealed the 7th June 1870, and dated the 8th April 1870.

PROVISIONAL SPECIFICATION left by the said Cromwell Fleetwood Varley at the Office of the Commissioners of Patents, with his Petition, on the 8th April 1870.

I, CROMWELL FLEETWOOD VARLEY, of Beckenham, in the County of Kent, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN ELECTRIC TELEGRAPHS," to be as follows :—

This Invention has for its object the increase of the transmitting power of telegraph circuits by enabling more than one operator to signal independent messuages at the same time upon one and the same wire to and from independent stations.

In working land lines it is usual to produce the signals by means of the passage of a current of electricity producing magnetic action, as in the Morse or Hughes instruments, or chemical action, as in the Baines machines.

By my Invention I superpose upon the currents used for working the ordinary telegraphs rapid undulations or waves which do not practically alter the mechanical or chemical power of the ordinary signal currents, and by new apparatus herein-after described these undulations are made to produce distinct and independent audible or other signals so long as these undulations are produced, whether ordinary signal currents be flowing or not.

As a rough mechanical illustration of the way in which I propose to pass two sets of electric signals simultanously and in either direction through the same line wire without interference I will suppose a rope stretched over two distant pulleys by means of weights at each end; if the near weight be raised the distant one falls. In this way signals are transmitted by the connecting rope, which may be called current signals; if now two small pulleys capable of rising and falling rest upon the rope between but near to the supports they will simply rotate when the rope is shifted backwards and forwards; if now an operator at one end strike the rope vibrations or waves will be produced which will cause the other small pulley to dance or make vibration signals. Consequently the operator who shifts and the operator who strikes the rope can each produce independent signals on one and the same rope. Suppose the rope to travel over several fixed pulleys the operation of shifting the rope will produce distinct current signals from end to end of the line as before, but between each fixed pulley vibrations can be produced, and so a number of intermediate stations can communicate independently of each other and independently of the current signals through the line.

With this mechanical simile the following will be more easily understood.

The way in which I carry my electric Invention into operation is as follows:—

An electro-magnet offers at the first moment great opposition to the passage of a current of electricity, and therefore it may be considered as partially opaque to the transmission of very rapid alternations or electric waves. I attach to the line at desirable parts condensers. In the first instance I will assume only two condensers, one at each end, attached near each end of an ordinary telegraph line. The first or communicating station produces in its condenser rapid charges and discharges; these add to and take from the line a number of small electric impulses without affecting the mean magnetizing power of the currents through the line. These impulses charge and discharge the second condenser at the other end.

These undulations in the second condenser can be utilized in the following manner:—

1. If the condenser be made of paper and metal foil the rapid charges and discharges produce a musical sound.

2. If those rapid alternations be made to pass round a helix containing an iron rod a musical sound is produced.

3. If these currents pass round a helix containing a magnetized harmonium tongue the currents make it vibrate audibly if the currents be properly timed, and the effect is increased if a feeble current of air be passing the tongue. By adding tubes of proper length and sounding boards and other appliances for communicating vibrations the power of the signal is increased.

4. By placing the magnetized tongue of a musical comb between the poles of an electro-magnet with only a small iron core, or inside a coil, it is made to vibrate whenever these undulations are passing.

Another method of producing sound from the undulations consists of stretching a music wire through hollow trelices; the currents magnetize and demagnetize the tone, this wire being also placed between the poles of permanent magnets. Harmonious currents cause this wire to vibrate. In some cases it may be useful to employ inharmonious currents to stop or silence the vibrations. The two latter methods will only speak when vibrations or harmony with the tongue are made to pass, and consequently in some cases two or more distinct sets of vibrations can be made to act on two or more sets of apparatus differently tuned, and to permit of several distinct communications to be transmitted simultaneously upon the same section of a single line wire. By introducing between the receiving condenser and a Morse or other ordinary receiving instrument a current reverser keeping time with the vibrations, these alternating currents are made to flow through the receiving instrument in one direction, and are then competent to work the Morse or other ordinary receiving instrument.

6. When it is desirable to subdivide the vibrating sections of a line an electro-magnet, or, what is better, two electro-magnets are inserted in

the circuit, and a condenser may with advantage be placed between the circuit and the earth connecting the condenser with the circuit between the two electro-magnets. In this way, without interfering materially with the ordinary signals through the line, the vibrating sections are separated from each other by withdrawing the iron cores from the electro-magnets, or short circuiting the electro-magnets the vibrations are passed through to the next station.

7. Another method consists of inserting a reflecting galvanometer between the condenser and the earth (or between the line and the condenser); the vibratory or secondary signals can be read off by observing its vibrations.

8. Vibrations are rendered sensible by placing a moveable iron bar between the poles of an electro-magnet or inside a helix, and one or both of its ends between the poles of permanent magnets; the latter are covered with brass or any non-magnetic matter; the vibration currents cause it to vibrate between the poles of the electro or permanent magnets, and so produce distinctly audible sounds.

9. There are other methods of utilizing these superposed vibrations, such as connecting to the condenser an electrometer like that of Milner or Pettier. An intermediate Morse or other such line instrument would cut off the vibration signals or reduce them much; this opposition of the intermediate electro-magnet may be cut off by connecting the terminals of a condenser to the circuit on each side of the magnet.

There are several methods of producing these vibrations in the wire :—

1st. If a tuning fork be placed between the poles of an electro-magnet with a spring contact so arranged that when at rest the battery current flows through the electro-magnet the latter will attract the tuning fork and break the circuit; the magnetism then ceases and the tuning fork springs back and renews the circuit; in this way it keeps vibrating so long as the battery is in action. A secondary wire around this magnet produces currents in opposite directions, and by placing this secondary wire in circuit with the line wire the necessary vibrations are produced.

2nd. The secondary wire may be connected between the earth and the condenser attached to the line wire; this method does not add to the resistance of the main circuit, and is therefore preferable.

3rd. A tongue similar to those used in harmoniums is made to vibrate by air between contact points, and so connect the condenser alternately with the battery and the ground, and so produce the alternations, or it may be made to connect the condenser alternately to the + or − pole of a bettery whose opposite poles are connected to the earth.

4th. A magneto machine rapidly rotating will do the above duty equally well if its speed of rotation be controlled by a good governor. The tuning fork and vibrating tongue arrangement can be set to and can keep up any desirable rate of vibrations. The ordinary telegraph keys and switches are used for connecting the various parts of the apparatus together. In constructing the dry paper condensers it is best to dip the paper in varnish and attach metal leaf (such as gold, silver, or copper) to the paper, and lay these metal-coated papers between metal foil.

The double-speaking apparatus of Dr. Gintl, or of Firschen, can be used on lines working with the above-described vibrations. When these are used I prefer inserting a hollow helix between the double speaker and the line, and by inserting iron rods in this helix the difficulty arising from the inductive capacity of the line is almost wholly removed. This is a new improvement, and will render these apparatus actually useful instruments.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Cromwell Fleetwood Varley in the Great Seal Patent Office on the 8th October 1870.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, CROMWELL FLEETWOOD VARLEY, of Beckenham, in the County of Kent, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Eighth day of April, in the year of our Lord One thousand eight hundred and seventy, in the thirty-third year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Cromwell Fleetwood Varley, Her special licence that I, the said Cromwell Fleetwood Varley, my executors, administrators, and assigns, or such others as I, the said Cromwell Fleetwood Varley, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term